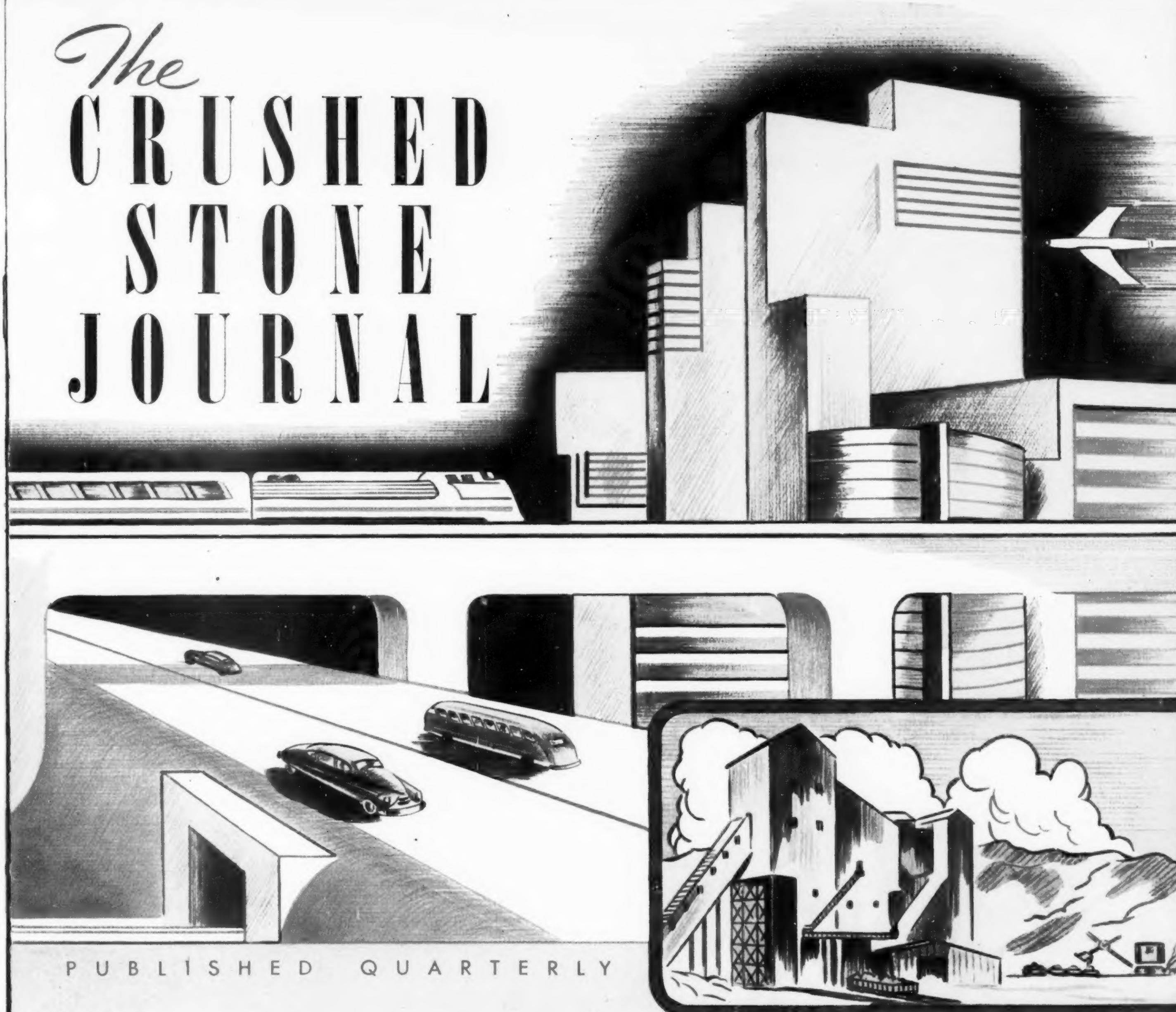
# The CRUSHED STONE JOURNAL



PUBLISHED QUARTERLY

## In This Issue

**June 1954**



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No. 2. How to Proportion Concrete for Pavements

No. 3. Uses for Stone Screenings

No. 4. How to Determine the Required Thickness of the Non-Rigid Type of Pavement for Highways and Airport Runways

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No. 6. The Bituminous Macadam Pavement

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No. 10. Stone Sand (Supply Exhausted)

No. 11. A Method of Proportioning Concrete for Strength, Workability, and Durability. (Revised November 1953)

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Manual of Uniform Cost Accounting Principles and Procedure for the Crushed Stone Industry (*$2.00 per copy*)

# The Crushed Stone Journal

Official Publication of the NATIONAL CRUSHED STONE ASSOCIATION

J. R. BOYD, Editor

NATIONAL CRUSHED STONE ASSOCIATION

1415 Elliot Place, N. W.
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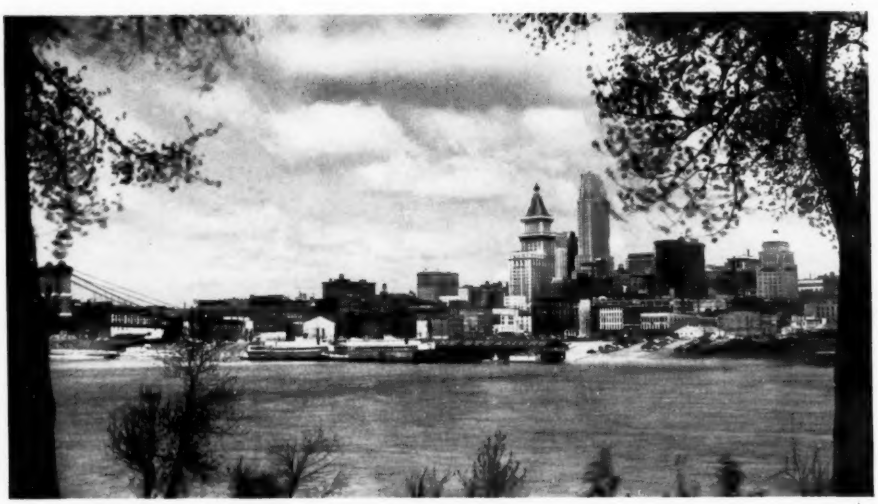

Cincinnati Skyline

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*Netherland Plaza*

CINCINNATI, OHIO

# THE CRUSHED STONE JOURNAL

WASHINGTON, D. C.

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# Bituminous Concrete with Particularly Good Non-Skid Characteristics

**By JOSEPH E. GRAY**

**Field Engineer**
**National Crushed Stone Association**
**Washington, D. C.**

SLIPPERINESS of pavements is rather a widespread problem and is due to a number of causes, of which the characteristics of the aggregates are only one. When engineers are confronted with a particularly serious condition, the problem has been solved by using materials that have a high coefficient of friction or skid resistance and which, sometimes, have been shipped a long distance. One of the objections to this procedure is the cost. Aggregates are a heavy commodity which have a restricted marketing area because of the high cost of transportation. The ultimate objective of engineers is, therefore, to build roads with the usual materials available that will have satisfactory non-skid characteristics.

It was learned that Illinois had been building a type of bituminous road with a history of acceptable performance with respect to non-skid properties. Accordingly a trip was made to Illinois to see these roads and possibly to learn how such non-skid surfaces were being obtained. This article consists of a report of the inspection and a discussion of hot mixed, hot laid bituminous concrete, with particular attention being given to the characteristics of the aggregates with respect to slipperiness.

The general area in which the inspection of the hot mixed, hot laid bituminous concrete, classified according to the state specification as Class I, Subclass I-11, and popularly known as "Eye-eleven," was between Springfield and Chicago. The topography of the country is flat, which has facilitated the construction of roads with long tangents and good sight distances. In fact, only one sign of "Slippery When Wet" was seen, which was placed at the beginning of a flat horizontal curve in a town. At no intersections, especially where stop signs or lights were placed, were there any indications of slipperiness. It may reasonably be concluded that the topography of the area is a natural aid conducive to safe stopping.

A tabulation of the mileage constructed by years gives a quick conception of the development and the acceptance of "Eye-eleven" as a satisfactory surfacing. In 1942, the state began using this type of mix and the record of the mileages laid from 1944 to 1952 is as follows:

| Year | Mileage Constructed | Year | Mileage Constructed |
|---|---|---|---|
| 1944 | 180 | 1949 | 230 |
| 1945 | 152 | 1950 | 98 |
| 1946 | 143 | 1951 | 388 |
| 1947 | 220 | 1952 | 900-1,000 |
| 1948 | 214 | | |

### Report on Inspection

Since the inspection was limited to I-11, bituminous concrete, the plan was to travel over as many miles as time permitted of pavements of different ages, to make frequent stops for a close inspection of the surface, and to observe any evidence that indicated a non-skid or a slippery condition. Observations were made on pavements less than one year old and up to twelve years old. The I-11 surface course, when newly laid, is black in color with a rather coarse texture that appears somewhat open. Yet, upon inspecting a road laid in 1953 on a day of heavy intermittent showers, it was observed that the surface dried quickly, which indicated a tight

dense mix. Of course, the drying was more rapid in the lanes of traffic; however, the pavement dried uniformly for great lengths, which would lead one to believe that the pavement was laid with a mix of uniform gradation, at a fairly constant temperature, and well compacted. Figures 1 and 2 show this pavement.

FIGURE 1
I-11. Route 54 South of Kankakee. Built 1953

FIGURE 2
Close-up of I-11 After a Rain. Route 54 South of Kankakee. Built 1953

By the time the pavement is two years old it has developed a texture which seems to remain uniform for years. This texture appears rough, with the stone slightly above the bituminous mortar. Traffic has worn the asphalt coating off of the surface of the crushed limestone coarse aggregate so that the color is a mottled white with a black background, which results in a light gray surface. The pavement appears very dense without an excess of asphalt. Figures 3 and 4 show an I-11 pavement two years old on Route 23 north of Streator.

In confirmation of the statement that after about two years of moderate traffic the pavement develops a texture which remains for years, the condition of the surface on Route 17 near Dwight is a good example. This I-11 surface was laid in 1943 over an

FIGURE 3
I-11, 2 Years Old. Route 23 North of Streator

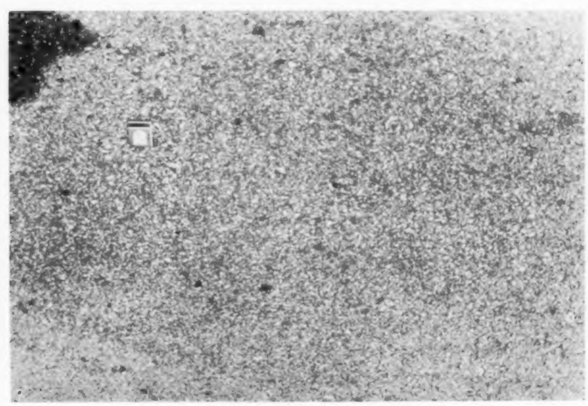

FIGURE 4
Close-up of I-11, 2 Years Old. Route 23 North of Streator

old portland cement concrete pavement. The cracks in the concrete have come through to the surface; however, the texture is quite similar to that of the pavement on Route 23 north of Streator, except that it is whiter. A close examination of this surface showed that an occasional fragment of stone had developed a polished surface, but by far the greater percentage of the stone had not taken on a polish. Figures 5 and 6 show the condition of the road on Route 17 near Dwight, which was surfaced in 1943.

FIGURE 5
General View of I-11 Laid in 1943. Route 17 Near Dwight

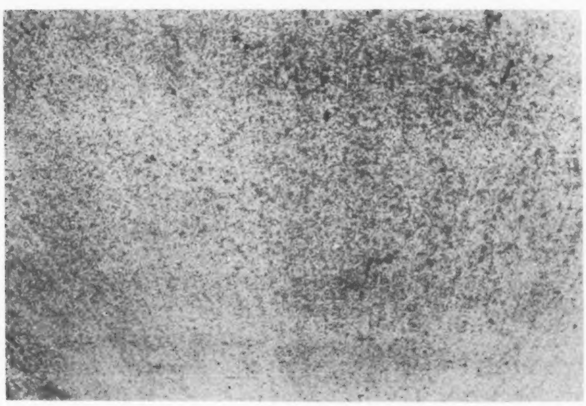

FIGURE 6
I-11 Laid in 1943. Route 17 Near Dwight. Close-up of Surface

It is indicated from this survey that the hot mixed, hot laid bituminous concrete, I-11, as placed in Illinois does possess good skid resistance characteristics. The state engineers with whom slipperiness as to I-11 pavements was discussed said that skidding on this pavement was not a problem with them.

### Design of Mix

A review of the mix design may give a clue as to why these surfaces are so good. Specifications for the surfacing course have a range in size requirements and asphalt content that give little information as to design except that the mid-points closely approach the desired mix. The specifications for I-11, bituminous concrete surface course, fine, dense-graded aggregate type are as follows:

COMPOSITION

| Sieve Size | | Per Cent | |
|---|---|---|---|
| Passing | Retained | | |
| Aggregate | | | |
| 1/2 in. | | 95-100 | |
| 1/2 in. | No. 4 | 25-50 | 45-65 |
| No. 4 | No. 10 | 10-30 | |
| No. 10 | No. 40 | 5-18 | 25-40 |
| No. 40 | No. 80 | 7-22 | |
| No. 80 | No. 200 | 5-13 | |
| No. 200 | | 4-8 | |
| Bitumen | | 5-7 | |

Mixes are designed by the Marshall method, based on the following criteria:

| Traffic | Material Retained on No. 10 sieve, per cent | Flow (0.01 in.) | Stability |
|---|---|---|---|
| Light to Medium | 55 | 16 ± 4 | 1200 minimum |
| Medium to Heavy | 57 | 12 ± 4 | 1500 minimum |

Medium traffic is considered as from 20 to 150 semi-trailers or from 100 to 500 commercial vehicles per day.

In the opinion of one of the state engineers, on the average a good I-11 mix would analyze about as follows:

| Aggregate | | Per Cent |
|---|---|---|
| 1/2 in. to No. 10 crushed stone | | 58 |
| *split* *1/2 in. - No. 4* | *42* | |
| *split* *No. 4 - No. 10* | *16* | |
| No. 10 to No. 200 sand | | 31 |
| *split* *No. 10 - No. 40* | *13* | |
| *split* *No. 40 - No. 80* | *11* | |
| *split* *No. 80 - No. 200* | *7* | |
| Minus 200 or filler | | 5.3 |
| Bitumen | | 5.7 |
| Total | | 100.0 |

| | |
|---|---|
| Marshall stability | 2,000 |
| Flow | 12-14 |

### Aggregate Characteristics

The general characteristics of the aggregates used are rather important when discussing slipperiness. While most of the crushed stone is commercially known as "limestone," actually there is a wide range

in the chemical and physical properties of the crushed stone available. They range from argillaceous limestones and dolomites to relatively pure limestones and dolomites to siliceous limestones and dolomites. It would seem reasonable to infer that the non-skid surface condition is not due to stone of uniform quality, but possibly may be due to the use of stone of variable hardness.

The coarse sand used, locally known as "torpedo sand" when from bank deposits, consists essentially of sharp particles of limestone and siliceous material. This same type of sand when obtained from river beds has grains that are rounded, which has been considered a source of trouble due to channeling or rutting on approaches to stop lights where traffic moves in well defined lanes.

Fine sand, which is usually dune sand, consists of siliceous material.

A typical gradation of these aggregates as they are fed to the drier is as follows:

| Sieve Size | | Coarse Aggregate | Fine Aggregate | |
|---|---|---|---|---|
| | | Crushed Limestone | Torpedo Sand | Dune Sand |
| Passing | Retained | Per Cent | | |
| 1/2 in. | 3/8 in. | 4.0 | | |
| 3/4 in. | No. 4 | 84.0 | 1.2 | |
| No. 4 | No. 10 | 10.6 | 22.2 | |
| No. 10 | No. 40 | 1.4 | 52.4 | 1.6 |
| No. 40 | No. 80 | | 21.0 | 56.8 |
| No. 80 | No. 200 | | 1.9 | 41.6 |
| No. 200 | | | 1.3 | 0.0 |

Filler is added to the mixture of hot aggregates at the boot of the hot elevator at a controlled rate to supply the additional fines needed.

### Discussion

The performance record and the variability of the coarse aggregate lends support to the theory that the non-skid characteristics of this surfacing mix are due to a combination of conditions. The surface contains a high percentage of crushed stone which makes it compare favorably with what Professor Moyer[1] describes as "open-graded" and states . . . "taking all factors into account an open-graded plant mixed surface using properly graded angular aggregate up to 3/8 in. maximum size should provide high skid resistance, high stability, a smooth riding surface, no splash during or after rains, and if light colored aggregate is used, will provide good light reflecting properties for night driving." These roads develop the surface as Professor Moyer describes, probably due to good design of a high stone content plus a very careful control of the asphalt content, which may be described as on the lean side, but sufficient to provide for a durable mix. The exposed bituminous mortar portion of the surface has a definite gritty, sand-paper feel.

Nevertheless, why does not this stone polish? The answer to this question may be for either of two reasons. Possibly it is an inherent characteristic of the stone. Occasionally a polished fragment was observed, but generally the stone surfaces do not polish. Previous experience has indicated that purity has little to do with this property, for there are pure and clayey limestones which both polish. On the contrary, there are siliceous limestones and pure limestones which do not polish. The most likely clue to these non-skid surfaces may be gained from an experience of several years ago. Stopping distance skid tests were being made on pavements in which a limestone that was known to develop a polished surface had been used. On every project in which the limestone and silica sand was used as the fine aggregate, the pavement had adequate skid resistance, and the limestone did not have a polished surface. On the other hand, when the limestone was used with a limestone sand, a slippery surface was evident. Also, there have been other experiences which confirm the idea that adequate skid resistant surfaces may be obtained by the combination of limestone coarse aggregate and siliceous sand fine aggregate. Thus, the inference is that the I-11 pavements are not slippery because of the possible inherent characteristics of the limestone. However, it seems more probable that the I-11 surfaces are non-skid because of the combined properties of stone of variable hardness, coarse sand of variable hardness, and fine sand of extreme hardness.

It is believed that in these bituminous mixes the use of a low asphalt content with properly graded sand provides a mortar that is gritty and effective in developing a non-skid surface. If the mortar portion is too rich in asphalt or the sand is poorly graded so that the mortar portion is essentially a mastic, it may be ineffective in preventing slipperiness.

The indications are that the non-skid characteristic of the bituminous concrete, I-11, as used in Illinois is due to the combined effects of good design, good control and inspection, good materials, and good construction practices.

(Continued on page 12)

1 Highway Research Board Bulletin No. 37

# Rehabilitation of Highway Pavements

**By WILLIAM L. CHILCOTE**

**Deputy Highways Engineer**
**Department of Public Works**
**Bureau of Highways**
**Baltimore, Maryland**

REHABILITATION of highway pavements is a relatively new development in paving technique. Heretofore, we considered only the construction of new pavements and their subsequent maintenance. With the ever increasing demand for good highways, and the necessity for keeping the cost of these highways within our financial ability to pay the bill, we must conserve the equity we have in these existing facilities—and realize the most for each tax dollar spent. This conservation of equity in our highway system is accomplished through rehabilitation.

Let us now differentiate between new construction, maintenance, and rehabilitation. Both new construction and reconstruction can be considered in the same category,—i.e., the roadway is completely new, from subgrade to finished surface. This new construction is a capital improvement. After the new roadway pavement is constructed and in service, it is maintained and kept in good condition. This is maintenance. When maintenance approaches a point where it is neither economical nor practical to continue, or the roadway is cut up from the installation of underground services, then the roadway pavement must be restored. By repairing or patching the old pavement, curb, etc., adjusting surface structures, leveling up depressions, and completely surfacing or resurfacing the entire roadway with hot-placed bituminous materials, the entire pavement is restored. This is rehabilitation.

For all practical purposes, a rehabilitated roadway will give the same service as a newly constructed roadway. The techniques involved are simple. For example, it is reasonable to assume that after an old roadway pavement has been in service for several years it has become adjusted and set to physical conditions, and except possibly for a few sections, it is resting on firm subgrade. The first step then, is to make repairs where these base failures occur, and these repairs should be kept to a minimum. Then the entire roadway surface is cleaned and given a "tack-coat" of asphalt emulsion, which both seals up the cracks and acts as a cementing medium. All low spots and depressions are "leveled up" using a hot plant mixed asphaltic concrete binder. The entire roadway is then covered with a hot-plant mixed asphaltic concrete binder—sheet asphalt surface—placed with paving machines in two courses; or a bituminous concrete surface—placed in either one or two courses. These materials are compressed while they are hot, by rolling until the surface is smooth.

On roadways where surface car operations have been discontinued, and the old steel rails abandoned in place, the foregoing procedure applies, except the steel rails are "plugged" and the railway area leveled up with hot asphaltic materials. From experience to date, covering these old rails does not offer any difficulty. On the other hand, it is quite possible that the steel rails supported both by the roadway slab and the stone ballast, offers additional stability. Even though the old ties "rot-out" there is no concentration of stress from the steel car wheel, and the load rather than being distributed through the wood ties is transmitted through the surrounding slab to the stone ballast. This old stone ballast acts as a base, and it apparently offers considerable stability. In Baltimore City, approximately 150 miles of abandoned rails have been covered by the foregoing method.

In many instances an existing roadway pavement is quite "cut-up" from the installation of sub-surface utilities and services. Rather than tear up the old pavement completely, the cut areas are repaired, and the entire roadway is surfaced or resurfaced with hot-placed asphaltic materials, as previously outlined. After a roadway is rehabilitated, in line with the foregoing techniques, and all surface water sealed off, the life of the pavement is greatly prolonged. In Baltimore City, more than 15,000 service cuts are made in the public highways each year.

Also, for example, in Baltimore City, all new arterial highways are constructed of concrete or macadam,—to a 9 in. depth, on a well prepared and stabilized subgrade or sub-base. In the residential areas, new concrete highways are constructed to a 7 in. depth. These concrete highways are not surfaced with bituminous materials until such time as they require rehabilitation, as previously outlined.

We now consider the economic significance of this rehabilitation work. Unlike newly constructed pavements, which are capital improvements and usually financed from loan funds, rehabilitation work can and should be financed on a "Pay-As-You-Go" basis

from gasoline and automobile tax revenues collected annually because this type work does not require nearly so extensive a capital outlay of funds, and its life expectancy is somewhat shorter.

Of course, the ideal situation would be to carry the entire highway paving program on a "Pay-As-You-Go" basis; however, this method is not always practical. Often large sums of money are required to make an improvement that will last many years, and therefore payment of the cost should be distributed over a number of years—thus we resort to the loan fund—bond issue method. But all the highway work—particularly the rehabilitation and maintenance work, should not be financed by this method or we would always be in a financial rut.

Few cities can finance an extensive highway reconstruction program from currently collected funds, and continue to successfully carry on other necessary operations, and make capital improvements. Our problem then is to prolong the life expectancy of highway pavements comparable to the community's financial ability to pay the bill. This can be accomplished through rehabilitation. For example, a new 9 in. concrete highway that would originally cost $8.50 per sq yd, based on a thirty-five year maximum life expectancy, with no surfacing, would cost $0.243 per sq yd per year, and even though it were properly maintained, at the end of thirty-five years it would require complete replacement. Let us now apply the rehabilitation principle. If this same highway were surfaced with sheet asphalt at the end of twenty years, the life of the pavement will be prolonged to at least forty-five years, at a relative cost of $0.227 per sq yd per year. If this same highway were resurfaced at the end of forty-five years, an additional twenty years can be added to its life, and the highway will give useful service for sixty-five years, at a relative cost of $0.183 per sq yd per year.

There is no apparent reason why these highways cannot be resurfaced a second time, provided the materials are feathered out at the curb and the crown is not too excessive, and it is very conservative to estimate that this second resurfacing will add another fifteen years to the life of the pavement. In summation, we then have a total useful life expectancy for the pavement of eighty years, at a cost of $0.17 per sq yd per year. This means there is an over-all savings of $0.073 per sq yd per year, extending over an eighty-year period. Here is an example of the rehabilitation technique working.

The following schedule indicates the relative cost for rehabilitating both a 9 in. and a 7 in. concrete pavement.

RELATIVE SCHEDULE OF COSTS PER YEAR PER SQUARE YARD OF PAVEMENT FOR VARIOUS CONDITIONS

| Type of Pavement | Cost Per Sq Yd | Maximum Average Years of Service | Unit Cost Per Sq Yd Per Year |
|---|---|---|---|
| 9 in. Concrete, Unsurfaced | $8.50 | 35 | $0.243 |
| 9 in. Concrete with | | | |
| 2 in. S.A. Surfacing & | 8.50 | 20 | |
| 2 in. S.A. Resurfacing | 1.70 | 25 | |
| | 10.20 | 45 | 0.227 |
| 9 in. Concrete with | 8.50 | 20 | |
| 2 in. S.A. Surfacing & | 1.70 | 25 | |
| 2 in. S.A. Resurfacing | 1.70 | 20 | |
| | 11.90 | 65 | 0.183 |
| 9 in. Concrete with | 8.50 | 20 | |
| 2 in. S.A. Surfacing | 1.70 | 25 | |
| 2 in. S.A. Resurfacing & | 1.70 | 20 | |
| 2 in. S.A. Resurfacing | 1.70 | 15 | |
| | 13.60 | 80 | 0.170 |
| 7 in. Concrete, Unsurfaced | 6.00 | 25 | 0.24 |
| 7 in. Concrete with | 6.00 | 15 | |
| 2 in. B.C. Surfacing | 1.50 | 20 | |
| | 7.50 | 35 | 0.214 |
| 7 in. Concrete with | 6.00 | 15 | |
| 2 in. B.C. Surfacing & | 1.50 | 20 | |
| 2 in. B.C. Resurfacing | 1.50 | 15 | |
| | 9.00 | 50 | 0.180 |

For the purpose of comparison, let us now see how this rehabilitation technique has been used in Baltimore City. In retrospect, much has been accomplished in this city during the past six years, since the rehabilitation techniques were introduced and adopted. Six years ago the paving situation in Baltimore was the paramount and most critical public works issue. Today—that bad situation has been corrected. During the six-year period, more than 700 miles, or 12.7 million square yards of highway pavement have been rehabilitated, at a cost of approximately 21.4 million dollars, and all this work has been done on a "Pay-As-You-Go" basis.

Suppose we had attempted to completely reconstruct those 700 miles of rehabilitated highways, then the cost would have been more than **100 million**

*(Continued on page 12)*

# Construction Features of the 1953 Indiana Test Road, U. S. Route No. 31

**A Summary by A. T. Goldbeck**

**Engineering Director**
**National Crushed Stone Association**

**of a Paper[1] by W. T. SPENCER**

**Soils Engineer of Materials and Tests**
**Indiana State Highway Commission**
**Indianapolis, Indiana**

A PAPER describing the construction features of the 1953 Indiana Test Road on U. S. Route 31 was presented before the 37th Annual Convention of the National Crushed Stone Association by W. T. Spencer, Soils Engineer, Materials and Tests, of the State Highway Department of Indiana. This is an excellent paper in which are recorded in detail the methods used in the construction of this test pavement.

The 1953 Indiana Test Road was built in south-central Indiana for the purpose of comparing the flexible and rigid types of pavements. The concrete pavement is of 9 in. uniform thickness, laid on a dense granular sub-base of 5 or 6 in. thickness, a total of 14 to 15 in.

The flexible pavement consisted of 5 in. of bituminous concrete supported on 8 in. of waterbound macadam, which is constructed on 6 1/2 in. of open graded granular sub-base, a total thickness of 19 1/2 in.

The concrete pavement was built with normal equipment but it is interesting to note that for the flexible pavement the use of a heavy pneumatic compactor and a multiple shoe vibrator was stipulated.

It is not our present purpose to describe this construction minutely, but rather to record in sufficient detail the fact that a special test road has been built in Indiana so that, in the future, as the effects of traffic or weather or other influences begin to be revealed, the details needed to study these defects may be readily available. They are much too voluminous to permit of recording them in the present article, but Mr. Spencer's paper will be kept on file in the office of the National Crushed Stone Association.

[1] Presented by W. T. Spencer at the 37th Annual Convention of the National Crushed Stone Association held at The Conrad Hilton, Chicago, Ill., February 22-24, 1954

### Subgrade

It is interesting to know something of the materials used in this project. Minute studies were made of the subgrade soils and these were found to be sandy loams or silty loams, ranging from granular to almost impervious texture. The details as to where the various soils exist no doubt will require study should failure or defects occur in the surface. Full use of the basic soil data was made in the pavement design, especially for the flexible pavement sections.

Normally the sub-base used in Indiana for concrete pavements is of the open graded or drainable type. In this particular project, because of the favorable soil condition prevailing over most of the length, a dense sub-base was used, extending 1 ft beyond the edges of the pavement, placed in a trench section without drainage.

### Concrete Pavement

The concrete was air entraining and had an average modulus of rupture of 700 psi at 28 days. All

FIGURE 1
Placing and Compacting Sub-base Material

transverse joints are contraction joints spaced at 40 ft intervals. Dowels were used for load transfer across the joints and are 1 in. in diameter and 20 in. long, spaced 12 in. center to center. Tie bars were used at the center longitudinal joint. These are 1/2 in. rounds spaced 30 in. on centers and were 30 in. long. The center longitudinal joint was formed by sawing.

The aggregates for use in this project were required to have a satisfactory service record.

Much detail is given in the paper on the construction of the subgrade and the placement of the con-

FIGURE 2
Placing and Spreading of Concrete

crete. Excellent equipment was used and great care was taken to obtain an excellent job.

FIGURE 3
Finished Pavement Surface and Transverse Contraction Joint

**Flexible Pavement**

The subgrade under the flexible pavement was of the same soil types as under the concrete sections. However, there was some variation in the California Bearing Ratio (CBR) and to be conservative it was decided to design the thickness on the basis of a CBR of 5.5 which was near the lowest value obtained. The use of this value for the subgrade resulted in a total thickness of 19 1/2 in. which is sufficiently great to eliminate danger from frost action. Beginning at the top, the cross-section of the flexible pavement consists of 1 in. of asphaltic concrete, 1 1/2 in. of asphaltic concrete binder, 2 1/2 in. of asphaltic concrete base course, 8 in. of waterbound macadam base course and 5 in. of free draining sub-base.

It is interesting to note that the 8 in. of macadam was compacted in one operation by "Heavy Pneumatic Compaction Equipment" and a "Multiple Shoe Vibro-Tamper."

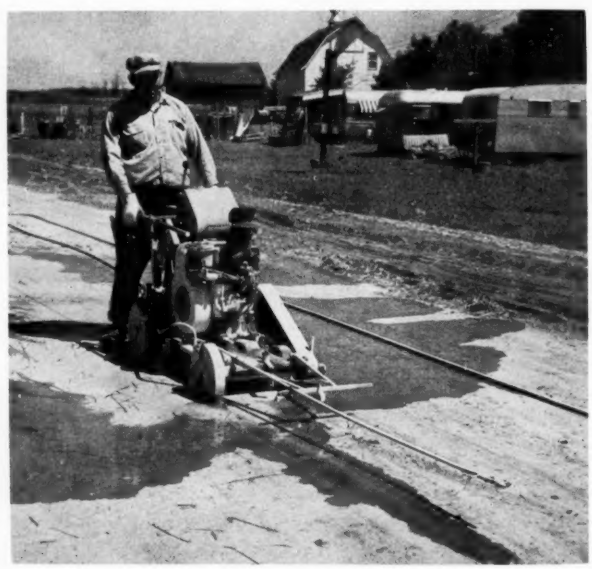

FIGURE 4
Sawing of Longitudinal Center Joint

The "Heavy Pneumatic Compaction Equipment" had a capacity of 50,000 lb gross or 25,000 lb per wheel. Pneumatic tires inflated to between 90 and 150 psi were used.

The "Multiple Shoe Vibro-Tamper" consisted of a number of independent metal shoes, each vibrated independently.

This equipment is said to have given excellent compaction to the courses upon which it was used. Many details of the placing and characteristics of the subgrade and other materials are given in the paper but must be omitted at present.

### Macadam Base Course

Limestone screenings were first placed on the granular base course to the amount of 100 lb per sq yd to serve as an inverted choke. The coarse stone was spread to a loose depth of 10 1/2 to 11 in. by means of an Apsco spreader modified by equipping the drive wheels with crawler treads and by adding another front wheel. After placing, the coarse aggregate was vibrated and key-rolled with three wheel, ten ton rollers. Then fines were added and vibrated into the voids. Four applications of fines were made, each followed by a single pass of the vibrator. Care was taken not to overfill the voids which would result in "jacking" the coarse aggregate.

FIGURE 5
Spreader Used to Place Coarse Aggregate for Water-Bound Macadam Base

Rolling of the waterbound base course by the heavy pneumatic tired roller then followed, and finally this was followed by the ten ton roller. It was found by means of test holes that the macadam base course was completely filled with screenings.

FIGURE 7
Key-Rolling Coarse Macadam Stone

FIGURE 6
Vibrating Coarse Aggregate

FIGURE 8
Heavy Pneumatic Compactor Loaded for Rolling Water-Bound Macadam

Details of the bituminous courses and their construction show that the only unusual departure from normal was the use of the heavy pneumatic roller on the finished surface course. This should have the

FIGURE 9
Pneumatic Roller on the Finished Surface Course. Roller Loaded to 50 Ton Capacity

effect of bringing about compaction to a considerable depth and, since the roller wheel load exceeds that of subsequent traffic, there should not be much vertical deformation of the bituminous surface in the future.

This whole project is excellently described in detail in Mr. Spencer's paper which will be filed for future reference at the headquarters of the National Crushed Stone Association.

## Bituminous Concrete

(Continued from page 6)

### Suggested Research Procedure

Researches in the analysis of the various factors affecting slipperiness of road surfaces are rather lacking. This is due in part to the fact that such researches do not lend themselves to laboratory study but should be conducted in the field. It seems that the best procedure for obtaining information on how to improve the skid resistance of pavements built with materials economically available is to study the effect of various designs and combinations of materials by building short experimental sections in various projects and observing their behavior.

### Acknowledgments

To R. H. Tittle, J. D. Lindsay, H. D. Rimbey, and Dean Anthrobus of the Illinois Highway Department; to F. A. Bentley of the Black Top Roads Company; to Dallas Pickett of the Lehigh Stone Company; and to others who so thoughtfully and constructively discussed with me this problem of slippery pavements, I wish to express my sincere appreciation.

## Highway Pavements

(Continued from page 8)

**dollars**, and the interest charges for financing this amount would have been approximately 20 million dollars, for a ten-year loan period, assuming an interest rate of 2 per cent.

As we now stand, the cost of rehabilitating those 700 miles of roadways was approximately 21.4 million dollars, and they were financed from currently collected funds, with no interest charges. It must be recognized that this rehabilitation work has been accomplished at a cost not much in excess of the interest charges, should the reconstruction loan method have been used. Also, the time element involved for completely reconstructing would have been prohibitive, particularly from a traffic point of view. For all intentional purposes, these rehabilitated highways have the same relative use value as totally new constructed highways. Therefore, in retrospect, we can well say,—much has been accomplished in the past six years.

Baltimore's highway rehabilitation work is an outstanding example and practical application of the rehabilitation theory. One can look back only a few years—when the streets were rough, full of pot holes and almost impassable. Today we have to look around for a rough street.

In prospect, we can expect even more in the years to come, because—through experiments, developments of new techniques and equipment, and further development of the existing methods, there is no apparent reason why the entire over-all rehabilitation operation cannot be further improved. Also, with certain minor adjustments or changes to suit local conditions, there is no apparent reason why these rehabilitation methods cannot be successfully used in any other city.

American Society for Testing Materials

ORGANIZED 1898 — ASTM — INCORPORATED 1902

**Frank E. Richart Award**

*Established through a gift of Mrs. Frank E. Richart to commemorate her husband by encouraging and recognizing meritorious contributions to the Society in research and standardization concerned with concrete and concrete aggregates.*

*This award is made to*

**Albert Theodore Goldbeck**

*For notable contributions to better highways and structures through sustained, painstaking research and standardization in materials.*

A. J. Painter — *Executive Secretary*

L. G. Beard, Jr. — *President*

*June 15, 1954*

## A. T. Goldbeck, Engineering Director of NCSA, Again Honored by American Society for Testing Materials

At the Annual Meeting of the American Society for Testing Materials, held in Chicago in June, our Engineering Director, A. T. Goldbeck, was again honored by the Society.

He is the first recipient of the Frank E. Richart award for "notable contributions to better highways and structures through sustained, painstaking research and standardization in materials."

The late Professor Frank E. Richart of the University of Illinois was known throughout the world for his researches in concrete and reinforced concrete and Mr. Goldbeck served with him on several committees, including Committee C-9 on Concrete and Concrete Aggregates, and also on the Joint Committee on Concrete and Reinforced Concrete. It is indeed an honor to receive an award commemorating the memory of such an illustrious engineer.

On the same day and almost within the same hour, Mr. Goldbeck received another honor, this time Honorary Membership on Committee D-4 on Road and Paving Materials of the ASTM, which Committee he had served as a member of the Executive Committee and as Second Vice Chairman for a period of twenty-five years.

He has been an Honorary Member of the American Society for Testing Materials since June 1951 and during that year he also received the Distinguished Service Award from the Highway Research Board "in recognition of outstanding achievement in the field of highway research."

# Federal-Aid Funds Apportioned Six Months in Advance

SECRETARY of Commerce Sinclair Weeks announced today, effective July 1, 1954, the apportionment of $875 million as federal aid to the states for highways, six months ahead of the time-limit set by Congress and several months earlier than apportionments for recent years.

This is the first step in the start of the new federal highway program, under the provisions of the Federal-Aid Highway Act of 1954, approved by the President on May 6, 1954. The Act authorizes a total of $1,932,000,000 for grants to states, with state matching money, and other federal highway projects for the fiscal years beginning July 1, 1955 and 1956. It is the largest two-year sum ever provided for federal highway programs.

The program is under the supervision of the Bureau of Public Roads, Commerce Department, Francis V. duPont, Commissioner.

Secretary Weeks said in a statement:

"The speed-up in starting time will have a favorable impact on the economy. One immediate result will be the letting by the states in the next 90 days of approximately an additional $100 million worth of contracts over and above the amount of contracts that otherwise would be let.

"As further planning and engineering is completed this year and contracts awarded for procurement and construction, there will be a steady increase in jobs not only among highway workers but also among those in enterprises supplying road-building equipment and highway and bridge materials.

"The Bureau of Public Roads in the next three months also will let contracts amounting to $2,500,000 for Public Land Highways and $10,000,000 for Forest Highways.

"Our highways urgently need modernization and expansion in order to cure deficiencies and to accommodate the users of the nation's 53 million motor vehicles. As a result of the President's program, all across the country we are going to have the greatest surge in highway construction in the history of America. That means better roads, safer driving, fewer traffic jams, stronger national defense, more jobs and stimulation of business along the improved and expanded highways.

"A gratifying feature of the nearly two billion-dollar program is that federal funds approximately equivalent to the revenue from federal gasoline taxes will now be used entirely for the improvement and expansion of the nation's highways."

**Facts on New Highway**

The $875 million, authorized by the Federal-Aid Highway Act of 1954, covers the following federal-aid projects.

Primary highway system—$315,500,000

Secondary system—$210,000,000

Primary highway system in urban areas—$175,000,000

National System of Interstate Highways—$175,000,000

The primary federal-aid system consists of 216,793 miles of rural highways and 17,882 miles of urban highways making a total of 234,675 miles. This is the general network of main highways of the country. Its most important arteries comprise the Interstate System. The system was designated in cooperation with the states as result of legislation in 1921.

The federal-aid system of secondary or farm-to-market is 460,002 miles in extent. This system was authorized in 1944 to be selected by state highway departments in cooperation with county officials and the Commissioner of Public Roads. It includes routes not a part of the primary federal-aid system selected to best serve the transportation needs of rural population.

The National System of Interstate Highways was designated in 1947 through cooperative action of the states and the federal government. It is limited by law to 40,000 miles and includes the most important highway routes of the country. These routes are to be improved to high standards developed in cooperation with the states particularly for this system. This system interconnects the largest cities and important producing areas of the country.

The funds will be expended under supervision of the Department's Bureau of Public Roads according to the general procedure in which state highway departments propose projects, prepare plans, award contracts, and supervise construction, all subject to federal approval.

Federal participation with primary, secondary, and urban funds is limited to half the cost, except in the public-lands states where participation may be increased above 50 per cent by one-half of the percentage of the area of the state that is public land.

Federal participation with $175,000,000 for the Interstate System is limited to 60 per cent of the cost except in public-lands states where the 60 per cent may be increased by four tenths of the percentage of the area of the state that is public land.

Federal-aid funds for the primary highway system are apportioned in proportion to area, population, and mileage of post roads, each being given equal weight.

Funds for secondary roads are apportioned in the same manner except that rural population is used rather than total population.

Funds for urban projects are apportioned in proportion to population in municipalities and other urban places of 5,000 or more.

One-half of the funds for the Interstate System is apportioned in the same manner as those for the federal-aid primary highway system and one-half on the basis of total population.

The complete list of state apportionments follows:

APPORTIONMENT OF FEDERAL-AID HIGHWAY FUNDS AUTHORIZED FOR THE FISCAL YEAR 1956

**Sums Apportioned For**

| State | Primary Highway System | Secondary or Feeder Roads | Urban Highways | Interstate System | Total |
|---|---|---|---|---|---|
| Alabama | $6,738,800 | $5,221,937 | $2,266,452 | $3,536,466 | $17,763,655 |
| Arizona | 4,723,075 | 3,216,555 | 672,891 | 1,967,160 | 10,579,681 |
| Arkansas | 5,257,058 | 4,207,659 | 967,757 | 2,500,144 | 12,932,618 |
| California | 14,495,550 | 7,463,481 | 15,378,016 | 9,770,990 | 47,108,037 |
| Colorado | 5,682,364 | 3,795,562 | 1,437,773 | 2,303,899 | 13,219,598 |
| Connecticut | 2,047,610 | 1,031,625 | 3,350,400 | 1,656,627 | 8,086,262 |
| Delaware | 1,547,437 | 1,031,625 | 354,790 | 1,074,610 | 4,008,462 |
| Florida | 5,130,153 | 3,353,655 | 3,102,050 | 2,930,809 | 14,516,667 |
| Georgia | 7,815,446 | 5,968,900 | 2,521,183 | 4,043,968 | 20,349,497 |
| Idaho | 3,892,551 | 2,737,969 | 332,940 | 1,734,315 | 8,697,775 |
| Illinois | 12,165,819 | 6,625,129 | 12,098,383 | 8,105,625 | 38,994,956 |
| Indiana | 7,496,268 | 5,167,153 | 4,138,722 | 4,219,185 | 21,021,328 |
| Iowa | 7,626,317 | 5,581,064 | 2,053,788 | 3,545,901 | 18,807,070 |
| Kansas | 7,663,996 | 5,365,736 | 1,625,973 | 3,169,963 | 17,825,668 |
| Kentucky | 5,820,681 | 4,832,404 | 1,796,525 | 3,216,870 | 15,666,480 |
| Louisiana | 4,920,796 | 3,561,657 | 2,535,907 | 2,824,725 | 13,843,085 |
| Maine | 2,649,624 | 1,896,107 | 723,013 | 1,387,518 | 6,656,262 |
| Maryland | 2,776,160 | 1,696,909 | 2,936,043 | 2,041,509 | 9,450,621 |
| Massachusetts | 4,011,085 | 1,489,563 | 7,200,476 | 3,655,217 | 16,356,341 |
| Michigan | 9,800,544 | 5,980,275 | 8,051,625 | 6,180,407 | 30,012,851 |
| Minnesota | 8,190,042 | 5,781,659 | 2,817,034 | 3,899,163 | 20,687,898 |
| Mississippi | 5,645,528 | 4,702,659 | 957,795 | 2,754,064 | 14,060,046 |
| Missouri | 9,204,910 | 6,228,008 | 4,260,427 | 4,707,609 | 24,400,954 |
| Montana | 6,342,359 | 4,362,904 | 407,361 | 2,419,110 | 13,531,734 |
| Nebraska | 6,157,523 | 4,366,021 | 1,014,628 | 2,436,110 | 13,974,282 |
| Nevada | 4,077,521 | 2,725,122 | 131,752 | 1,785,146 | 8,719,541 |
| New Hampshire | 1,547,437 | 1,031,625 | 512,324 | 1,074,610 | 4,165,996 |
| New Jersey | 4,083,014 | 1,373,973 | 7,572,939 | 3,753,573 | 16,783,499 |
| New Mexico | 5,133,654 | 3,526,748 | 567,747 | 2,081,652 | 11,309,801 |
| New York | 14,843,409 | 5,948,112 | 23,123,251 | 12,160,327 | 56,075,099 |
| North Carolina | 7,825,095 | 6,684,414 | 2,223,008 | 4,380,315 | 21,112,832 |
| North Dakota | 4,581,331 | 3,326,558 | 292,522 | 1,926,290 | 10,126,701 |
| Ohio | 11,011,801 | 6,698,563 | 10,010,967 | 7,369,446 | 35,090,777 |
| Oklahoma | 6,757,731 | 4,838,876 | 1,390,029 | 3,094,245 | 16,580,881 |
| Oregon | 5,398,620 | 3,772,987 | 1,387,166 | 2,330,696 | 12,889,469 |
| Pennsylvania | 12,394,224 | 7,375,924 | 13,096,579 | 9,134,669 | 42,001,396 |
| Rhode Island | 1,547,437 | 1,031,625 | 1,236,688 | 1,074,610 | 4,890,360 |
| South Carolina | 4,252,157 | 3,520,756 | 1,190,023 | 2,331,532 | 11,294,468 |
| South Dakota | 4,932,082 | 3,522,524 | 336,008 | 2,024,381 | 10,814,995 |
| Tennessee | 6,843,362 | 5,333,724 | 2,501,615 | 3,689,779 | 18,368,480 |
| Texas | 20,484,493 | 13,716,335 | 8,287,665 | 9,889,608 | 52,378,101 |
| Utah | 3,630,545 | 2,401,759 | 733,035 | 1,661,565 | 8,426,904 |
| Vermont | 1,547,437 | 1,031,625 | 269,364 | 1,074,610 | 3,923,036 |
| Virginia | 5,997,988 | 4,661,747 | 2,697,681 | 3,468,488 | 16,825,904 |
| Washington | 5,220,265 | 3,487,400 | 2,610,298 | 2,744,023 | 14,061,986 |
| West Virginia | 3,443,635 | 2,997,967 | 1,125,885 | 2,045,557 | 9,613,044 |
| Wisconsin | 7,460,276 | 5,205,165 | 3,387,619 | 3,939,418 | 19,992,478 |
| Wyoming | 3,938,080 | 2,668,860 | 188,100 | 1,746,386 | 8,541,426 |
| Hawaii | 1,547,437 | 1,031,625 | 581,732 | -------- | 3,160,794 |
| Dist. of Col. | 1,547,437 | 1,031,625 | 1,494,531 | 1,074,610 | 5,148,203 |
| Puerto Rico | 1,639,336 | 1,713,145 | 1,487,020 | -------- | 4,839,501 |

# Crushed and Broken Stone in 1952*

By L. M. OTIS
NAN C. JENSEN

**Under the Supervision of G. W. Josephson, Chief Construction and Chemical Materials Branch Minerals Division, U. S. Bureau of Mines Washington, D. C.**

CRUSHED and broken stone output in 1952, as reported by producers to the Bureau of Mines, United States Department of the Interior, was 298,791,340 short tons with a value of $408,356,785. Compared with 1951, this was 5 per cent greater in tonnage and 8 per cent greater in value.

During 1952, crushed and broken stone for concrete aggregate and road construction, 186,205,565 short tons, constituted 62 per cent of the total. The tonnage for these two uses was 10 per cent greater and the value 13 per cent greater than in 1951. Commercial operators produced 91 per cent of the stone for these uses.

Stone for metallurgical purposes, the second largest use, took 12 per cent of the total in 1952. Metallurgical stone output was 13 per cent lower than in 1951.

The third largest use was for railroad ballast, which consumed slightly over 7 per cent of the 1952 total, compared with 8 per cent in 1951. Limestone for agricultural purposes consumed slightly less than 7 per cent of the total 1952 tonnage.

As in the two previous years, limestone, including dolomite, constituted 72 per cent of all crushed and broken stone sold or used.

The following tables present some salient statistics of the crushed and broken stone industry in 1951 and 1952.

* Mineral Market Report, MMS. No. 2285

CRUSHED AND BROKEN STONE SOLD OR USED BY PRODUCERS IN THE UNITED STATES,[1] 1951-52, BY PRINCIPAL USES

| Use | 1951 | | | 1952 | | |
|---|---|---|---|---|---|---|
| | Short Tons | Value | | Short Tons | Value | |
| | | Total | Average | | Total | Average |
| Concrete and road metal | [2] 168,766,088 | [2] $216,418,613 | $1.28 | 186,205,565 | $245,567,866 | $1.32 |
| Railroad ballast | 21,368,552 | 20,336,868 | .95 | 21,383,068 | 20,019,095 | .94 |
| Furnace flux [3] | 39,929,957 | 45,622,125 | 1.14 | 34,908,815 | 41,119,351 | 1.18 |
| Alkali works | 7,708,686 | 7,207,496 | .93 | 6,557,940 | 6,448,388 | .98 |
| Riprap | 6,989,284 | 8,437,614 | 1.21 | 8,778,585 | 11,156,047 | 1.27 |
| Agriculture [3] | 19,400,610 | 31,051,933 | 1.60 | 20,683,548 | 33,803,245 | 1.63 |
| Refractory stone [4] | 2,365,804 | 7,810,013 | 3.30 | 1,950,786 | 7,262,048 | 3.72 |
| Asphalt filler | 1,047,223 | 3,159,714 | 3.02 | 1,002,849 | 2,934,211 | 2.93 |
| Calcium carbide works | 888,628 | 903,816 | 1.02 | 722,729 | 762,257 | 1.05 |
| Sugar factories | 563,064 | 1,369,475 | 2.43 | 541,419 | 1,404,391 | 2.59 |
| Glass factories | 793,896 | 1,906,751 | 2.40 | 814,302 | 1,933,165 | 2.37 |
| Paper mills | 445,861 | 943,300 | 2.12 | 359,904 | 820,769 | 2.28 |
| Other uses | 13,421,489 | 31,491,633 | 2.35 | 14,881,830 | 35,125,952 | 2.36 |
| Total | [2] 283,689,142 | [2] 376,659,351 | 1.33 | 298,791,340 | 408,356,785 | 1.37 |
| Portland and natural cement and cement rock [5] | 64,284,000 | (6) | ...... | 64,305,000 | (6) | ...... |
| Lime [7] | 16,511,000 | (6) | ...... | 16,146,000 | (6) | ...... |
| Grand total | [2] 364,484,000 | (6) | ...... | 379,242,000 | (6) | ...... |

[1] Includes Alaska, Hawaii, and Puerto Rico
[2] Revised figure
[3] Limestone
[4] Ganister (sandstone), mica, schist, dolomite, and soapstone
[5] Value reported as cement in chapter on Cement
[6] No value available for stone used in manufacture of cement and lime
[7] Value reported as lime in chapter on Lime

LIMESTONE (CRUSHED AND BROKEN STONE) SOLD OR USED BY PRODUCERS IN THE UNITED STATES,[1] 1951-52 BY USES

| Use | 1951 | | 1952 | |
|---|---|---|---|---|
| | Short Tons | Value | Short Tons | Value |
| Riprap | 3,101,470 | $4,042,798 | 4,872,450 | $6,424,388 |
| Fluxing stone | 39,929,957 | 45,622,125 | 34,908,815 | 41,119,351 |
| Concrete and road metal | 112,717,050 | 140,353,551 | 127,379,148 | 163,580,762 |
| Railroad ballast | 9,085,006 | 9,574,971 | 8,827,561 | 9,389,824 |
| Agriculture | 19,400,610 | 31,051,933 | 21,152,208 | 34,463,963 |
| Alkali works | 7,708,686 | 7,207,496 | 6,557,940 | 6,448,388 |
| Calcium carbide works | 888,628 | 903,816 | 722,729 | 762,257 |
| Coal-mine dusting | 384,905 | 1,523,306 | 421,847 | 1,685,124 |
| Filler (not whiting substitute): | | | | |
| Asphalt | 1,047,223 | 3,159,714 | 1,002,849 | 2,934,211 |
| Fertilizer | 630,016 | 1,198,395 | 599,856 | 1,165,437 |
| Other | 345,963 | 1,344,858 | 350,359 | 1,312,562 |
| Filter beds | 193,432 | 306,169 | 89,025 | 145,492 |
| Glass factories | 793,896 | 1,906,751 | 814,302 | 1,933,165 |
| Limestone sand | 799,980 | 962,244 | 1,697,657 | 2,157,633 |
| Limestone whiting [2] | 710,348 | 6,702,207 | 762,354 | 7,164,895 |
| Magnesia works (dolomite)[3] | 363,883 | 725,791 | 433,041 | 859,151 |
| Mineral food | 546,074 | 3,006,227 | 549,329 | 2,963,723 |
| Mineral (rock) wool | 39,412 | 52,675 | 10,811 | 14,119 |
| Paper mills | 445,861 | 943,300 | 359,904 | 820,769 |
| Poultry grit | 98,625 | 523,896 | 78,866 | 603,509 |
| Refractory (dolomite) | 1,112,186 | 1,519,831 | 707,741 | 1,047,662 |
| Road base | 1,484,602 | 1,309,597 | 1,370,970 | 1,244,975 |
| Stucco, terrazzo, and artificial stone | 80,244 | 800,266 | 121,192 | 1,085,853 |
| Sugar factories | 563,064 | 1,369,475 | 541,419 | 1,404,391 |
| Other uses [4] | 1,395,343 | 2,201,926 | 995,452 | 1,562,975 |
| Use unspecified | 806,509 | 1,034,891 | 1,140,872 | 1,568,586 |
| Total | 204,672,973 | 269,348,209 | 216,468,697 | 293,863,165 |

[1] Includes Hawaii and Puerto Rico
[2] Includes stone for filler for calcimine, caulking compounds, ceramics, chewing gum, explosives, floor coverings, foundry compounds, glue, grease, insecticides, leather goods, paint, paper, phonograph records, picture-frame moldings, plastics, pottery, putty, roofing, rubber, tooth paste, wire coating, and unspecified uses. Excludes limestone whiting made by companies from purchased stone
[3] Includes stone for refractory magnesia
[4] Includes stone for acid neutralization, athletic-field marking, carbon dioxide, chemicals (unspecified), concrete blocks and pipes, dyes, fill material, light bulbs, motion-picture snow, oil-well drilling, patching plaster, rayons, roofing granules, spalls, and water treatment

CRUSHED STONE SOLD OR USED IN THE UNITED STATES IN 1952,[1] BY METHODS OF TRANSPORTATION

| Method of Transportation | Commercial Operations | | Commercial and Non-Commercial [2] Operations | |
|---|---|---|---|---|
| | Short Tons | Per cent of Total | Short Tons | Per cent of Total |
| Truck | 140,079,971 | 51 | 162,742,225 | 54 |
| Rail | 89,079,668 | 32 | 89,079,668 | 30 |
| Waterway | 25,476,939 | 9 | 25,476,939 | 9 |
| Unspecified | 21,492,508 | 8 | 21,492,508 | 7 |
| Total | 276,129,086 | 100 | 298,791,340 | 100 |

[1] Includes Alaska, Hawaii, and Puerto Rico
[2] Entire output of noncommercial operations assumed to be moved by truck

STONE[1] SOLD OR USED BY PRODUCERS IN THE UNITED STATES, 1951-52 BY STATES

| State | 1951 | | 1952 | |
|---|---|---|---|---|
| | Short Tons | Value | Short Tons | Value |
| Alabama | 2,818,421 | $7,254,671 | 3,052,150 | $7,948,410 |
| Arizona | 308,881 | 353,872 | 235,020 | 355,709 |
| Arkansas | 2,535,746 | 3,216,426 | [2] 2,967,479 | [2] 3,346,201 |
| California | 12,537,344 | 14,714,524 | 14,374,930 | 17,697,085 |
| Colorado | 1,470,123 | 2,334,376 | 1,708,872 | 2,566,[illegible]01 |
| Connecticut | 2,278,466 | 3,360,378 | 2,837,045 | 4,101,060 |
| Delaware | 99,201 | 245,002 | 94,911 | 251,759 |
| Florida | 8,032,[illegible]66 | 9,419,682 | 7,836,634 | 9,577,541 |
| Georgia | [3] 5,234,131 | [3] 14,813,413 | 7,141,923 | 18,114,604 |
| Idaho | 1,457,182 | 1,811,422 | [2] 1,630,034 | [2] 2,441,236 |
| Illinois | 19,298,968 | 23,474,516 | 22,334,887 | 28,326,060 |
| Indiana | [2] 8,641,670 | [2] 23,729,433 | 9,126,837 | 21,965,454 |
| Iowa | 9,261,317 | 12,170,082 | 9,899,404 | 13,036,726 |
| Kansas | 7,191,483 | 9,058,512 | 8,830,871 | 12,051,740 |
| Kentucky | 7,048,771 | 8,609,609 | [2] 8,817,859 | [2] 10,816,707 |
| Louisiana | ............ | ............ | (4) | (4) |
| Maine | 644,594 | 2,582,541 | [2] 316,874 | [2] 1,795,768 |
| Maryland | 3,181,434 | 5,983,380 | [2] 3,391,679 | [2] 6,330,443 |
| Massachusetts | [2] 3,225,839 | [2] 9,172,425 | [2] 3,355,819 | [2] 9,331,871 |
| Michigan | 20,851,733 | 17,514,720 | 17,973,685 | 15,770,816 |
| Minnesota | [2] 1,906,407 | [2] 5,613,157 | [2] 2,394,178 | [2] 5,498,177 |
| Mississippi | 171,131 | 168,933 | 90,000 | 103,500 |
| Missouri | 11,294,227 | 15,255,427 | 15,106,544 | 20,676,958 |
| Montana | 871,508 | 986,327 | [2] 690,081 | [2] 792,897 |
| Nebraska | 942,967 | 1,437,899 | 1,245,106 | 1,946,448 |
| Nevada | 834,807 | 959,815 | 830,712 | 1,158,608 |
| New Hampshire | [2] 62,355 | [2] 349,606 | 69,850 | 546,177 |
| New Jersey | 6,457,248 | 10,987,705 | 6,102,324 | 12,307,480 |
| New Mexico | 1,022,901 | 592,179 | [2] 317,894 | [2] 191,642 |
| New York | 15,559,372 | 24,326,118 | 16,234,549 | 25,244,245 |
| North Carolina | [2] 8,612,967 | [2] 13,292,690 | [2] 9,647,513 | [2] 14,694,698 |
| North Dakota | 281,219 | 213,061 | 67,064 | 4,968 |
| Ohio | [2] 25,190,277 | [2] 36,436,081 | [2] 24,693,189 | [2] 36,197,485 |
| Oklahoma | 6,966,676 | 6,917,548 | [2] 9,636,475 | [2] 8,974,334 |
| Oregon | 8,721,799 | 10,831,483 | 6,250,849 | 8,893,368 |
| Pennsylvania | [2] 27,399,564 | [2] 46,668,590 | [2] 25,609,812 | [2] 44,676,456 |
| Rhode Island | 239,248 | 651,931 | 168,993 | 654,782 |
| South Carolina | [2] 2,828,868 | [2] 3,690,114 | [2] 2,914,839 | [2] 3,881,178 |
| South Dakota | 1,263,322 | 4,660,074 | 1,671,187 | 4,806,882 |
| Tennessee | [2] 8,838,796 | [2] 14,765,988 | 10,377,320 | 17,652,763 |
| Texas | [2] 7,351,069 | [2] 7,626,122 | 7,604,468 | 8,664,633 |
| Utah | 1,226,710 | 1,291,118 | [2] 852,351 | [2] 1,123,108 |
| Vermont | 450,980 | 7,253,824 | 404,391 | 6,016,530 |
| Virginia | 9,277,252 | 16,621,116 | 9,670,961 | 16,969,952 |
| Washington | 5,029,735 | 5,664,433 | 4,523,234 | 5,491,525 |
| West Virginia | [2] 5,754,378 | [2] 8,472,639 | [2] 4,869,442 | [2] 6,826,113 |
| Wisconsin | 7,609,323 | 14,671,858 | 8,578,882 | 16,754,675 |
| Wyoming | 1,645,475 | 1,857,267 | 1,466,567 | 1,688,890 |
| Alaska, Hawaii, and Puerto Rico | 1,395,332 | 2,904,678 | 1,682,299 | 4,313,501 |
| Undistributed | 226,648 | 1,842,438 | 989,683 | 2,799,985 |
| Total | [3] 285,550,831 | [3] 436,829,203 | 300,687,670 | 465,377,549 |

* Mineral Market Report MMS. No. 2285
[1] Includes—1951: 1,861,689 short tons of dimension stone valued at $60,169,852; 1952: 1,896,330 tons, $57,020,764
[2] To avoid disclosing confidential information, certain State totals are incomplete, the figures not included being combined with "Undistributed"
[3] Revised figure
[4] Included with "Undistributed"

# Corps of Engineers Releases Publication on "Concrete Aggregates"[1]

PORTLAND-CEMENT concrete as used in the construction of pavements, buildings, dams, and many other engineering works consists of aggregates cemented together with a paste composed of portland cement and water. From one-half to three-fourths or more of the concrete consists of aggregates. The materials most frequently used as aggregates are sand, gravel, and crushed stone. For special purposes, light-weight aggregates are used and when available other material such as crushed iron blast-furnace slag may also be used.

The Corps of Engineers, U. S. Army, requires that a survey be made to determine the properties of material locally and economically available that may be considered for use as aggregates in concrete for its construction projects wherever they may be located. This aggregate survey work is conducted for each project by the Division Concrete Laboratory nearest the site of the work. These laboratories are located in Portland, Oregon; San Francisco, California; Dallas, Texas; Omaha, Nebraska; Vicksburg, Mississippi; Atlanta, Georgia; and Cincinnati, Ohio. Under the Civil Works Investigations Program sponsored by the Office, Chief of Engineers, the Waterways Experiment Station began in 1950 to compile on Standard Data Sheets all of the information developed since 1946 in connection with aggregate surveys. The data which have been compiled to date cover 1,210 sources of material located within the continental United States. A data sheet has been prepared on each of these sources. The United States has been divided into rectangles each one degree of longitude in an East-West direction and one degree of latitude in a North-South direction. A map of each of these rectangles has been prepared and the aggregate sources plotted on the appropriate map. The 1,210 sources for which data are now available are located on 333 different one-degree maps. The United States has been divided into ten areas: Area 1 includes the Pacific Coast west of longitude 120. Area 2 includes the Northwest north of latitude 40, west of longitude 110. Area 3 is the Southwest, south of latitude 40 and west of longitude 110. Areas 4, 5, 6, 7, 8, and 9 are alternately north and south of latitude 40 and include the sections respectively west of longitude 100, 90, and 80. Area 10 includes that part of the United States east of longitude 80.

Five volumes of data have been published by the Waterways Experiment Station and distributed to appropriate Corps of Engineers District and Division Offices and Division Laboratories for information and reference. The volumes consist of loose-leaf binders and individual sheets with appropriate introductory matter and maps. Arrangements have been made for each of these laboratories to furnish to the Waterways Experiment Station additional data as they are developed. Annually the Waterways Experiment Station will distribute supplementary sheets to be inserted in the compilation—thereby keeping it complete and up to date. It is anticipated that as a result of the existence of this compilation, the costs for the investigation and study of additional samples from aggregate sources previously studied will be saved and that the cost of aggregate surveys for future projects will thereby be reduced. Although it is not feasible to issue these publications to private organizations and individuals, the data contained therein may be examined by such organizations and individuals, upon request, at any Corps of Engineers District or Division Office or Laboratory. In this connection, the Director, Waterways Experiment Station, will maintain several complete sets of these volumes to be made available on a loan basis.

Users of these data have been cautioned to consider the results given as indicative of the properties of the sample which was tested but not necessarily indicative of the properties of the material which may be produced from these sources in the future. Each data sheet includes the date on which the sample was taken and the laboratory at which it was tested. All of the data were obtained by the use of the methods of test which have been standardized by the Waterways Experiment Station and published for the use of the Corps of Engineers in the Handbook for Concrete and Cement, the maintenance of which is also a part of the Corps of Engineers program of Civil Works Investigations.

[1] Technical Memorandum No. 6-370, Volumes I-V, published by Waterways Experiment Station, Corps of Engineers, U. S. Army, Vicksburg, Mississippi

# Manufacturers Division—National Crushed Stone Association

**These associate members are morally and financially aiding the Association in its efforts to protect and advance the interests of the crushed stone industry. Please give them favorable consideration whenever possible.**

**Allis-Chalmers Mfg. Co.**
Milwaukee 1, Wis.
*Crushing, Screening, Washing, Grinding, Cement Machinery; Motors; Texrope Drives; Centrifugal Pumps; Tractors*

**American Cyanamid Co.**
**Explosives Department**
30 Rockefeller Plaza, New York 20, N. Y.
*Explosives and Blasting Supplies*

**American Manganese Steel Division**
**American Brake Shoe Co.**
109 North Wabash Ave., Chicago 2, Ill.
*Manganese Steel Castings, Power Shovel Dippers, Material Handling Pumps, Reclamation and Hard-Facing Welding Materials*

**American Pulverizer Co.**
1249 Macklind Ave., St. Louis 10, Mo.
*Manufacturers of Ring Crushers and Hammermills for Primary and Secondary Crushing*

**American Steel & Wire Division**
Rockefeller Bldg., 614 Superior Ave., N. W., Cleveland 13, Ohio
*Wire Rope, Aerial Wire Rope Tramways, Electrical Wires and Cables, Welded Wire Fabric, Concrete Reinforcing, Wire Nails, Fencing, Netting*

**Aquadyne Corp.**
441 Lexington Ave., New York 17, N. Y.
*"Wet Water"*

**Atlas Powder Co.**
Wilmington 99, Del.
*Industrial Explosives and Blasting Supplies*

**Bacon-Greene & Milroy**
29 Washington Ave., Hamden 14, Conn.
*"Farrel-Bacon" Jaw Crushers for Primary and Secondary Operations, Conveyors, Elevators, Rolls, Screens*

**Baker-Lull Corp.**
314 West 90th St., Minneapolis 20, Minn.
*Shovel Loaders (Front End)*

**Baldwin-Lima-Hamilton Corp.**
**Construction Equipment Division**
South Main St., Lima, Ohio
*Power Shovels, Draglines, Cranes, Bins, Conveyors and Idlers, Crushers and Pulverizers, Feeders, Plants—Crushing and Portable, Washing Equipment*

**Barber-Greene Co.**
400 North Highland Ave., Aurora, Ill.
*Portable and Permanent Belt Conveyors, Belt Conveyor Idlers, Bucket Loaders Both Wheel and Crawler Mounted, Asphalt Mixers and Finishers, Coal Handling Machines*

**Brunner & Lay Rock Bit Corp.**
350 Depot St., Asheville, N. C.
*Tungsten Carbide Detachable Bits, "Rock Bit" Drill Steel Inlaid with Tungsten Carbide, Carbon Hollow Drill Steel, Alloy Hollow Drill Steel*

**Buchanan, C. G., Crushing Machinery Div.**
**Birdsboro Steel Foundry & Machine Co.**
1941 Furnace St., Birdsboro, Pa.
*Primary and Secondary Crushers and Rolls*

**Bucyrus-Erie Co.**
South Milwaukee, Wis.
*Excavating, Drilling, and Material Handling Equipment*

**Buda Co.**
**Division of Allis-Chalmers Mfg. Co.**
154th St. and Commercial Ave., Harvey, Ill.
*Diesel and Gasoline Engines; Material Handling Equipment; Lifting Jacks; Earth Drills and Maintenance of Way Equipment*

**Cape Ann Anchor & Forge Co.**
Whittemore St., Gloucester, Mass.
*"Cape Ann" Forged Steel Drop Balls*

**Caterpillar Tractor Co.**
Peoria 8, Ill.
*Track-Type Tractors, Bulldozers, Earthmoving Scrapers, Motor Graders, Heavy-Duty Off-Road Hauling Units, Diesel Engines, Diesel Electric Generating Sets, Front End Shovels for Tractors or Tractor Loaders, Wheel-Type Tractors*

**Chain Belt Co.**
P. O. Box 2022, Milwaukee 1, Wis.
*Rex Conveyors, Elevators, Feeders, Idlers, Elevator Buckets, Drive and Conveyor Chains, Sprockets, Bearings, Pillow Blocks, Power Transmission Equipment, Portable Self-Priming Pumps*

**Clark Equipment Co.**
**Construction Machinery Division**
270 Miller St., Benton Harbor, Mich.
*Truck and Crawler Excavator Cranes, 3/8, 1/2, and 3/4 Yd.*

## Manufacturers Division—National Crushed Stone Association
(continued)

**Continental Gin Co.**
4500 Fifth Ave., S., Birmingham 2, Ala.
*Conveyors—Belt, Screw, Flight and Underground Mine; Elevators—Bucket and Screw; Feeders—Apron, Belt, Reciprocating, Table, and Screw; Drives—V-Belts, Chains and Sprockets, Gears and Speed Reducers*

**Cross Engineering Co.**
P. O. Box 507, Carbondale, Pa.
*Cross Perforated Steel Segments, Sections, Decks, for Vibrating, Shaking, Revolving, and Other Types of Screening Equipment*

**Cummins Engine Co., Inc.**
Fifth and Union Sts., Columbus, Ind.
*Lightweight Highspeed Diesel Engines (60-600 Hp.) for: On-Highway Trucks, Off-Highway Trucks, Buses, Tractors, Earthmovers, Shovels, Cranes, Industrial and Switcher Locomotives, Air Compressors, Logging Yarders and Loaders, Oil Well Drilling Rigs, Centrifugal Pumps, Generator Sets and Power Units, Work Boats and Pleasure Craft*

**Deister Machine Co.**
1933 East Wayne St., Fort Wayne 4, Ind.
*Deister Vibrating Screens, Classifiers, Washing Equipment*

**Detroit Diesel Engine Division General Motors Corp.**
13400 West Outer Drive, Detroit 28, Mich.
*Light Weight, Compact 2-Cycle Diesel Engines and "Package Power" Units for All Classes of Service*

**Diamond Iron Works, Division of Goodman Manufacturing Co.**
1728 North Second St., Minneapolis 11, Minn.
*Jaw and Roll Crushers; Vibrator, Revolving, and Scrubber Screens; Drag Washers; Bucket Elevators; Belt Conveyors; Bins; Apron and Plate Feeders; Portable Gravel and Rock Crushing, Screening, and Washing Plants; Stationary Crushing, Screening, and Washing Plants; Hammermills*

**Du Pont, E. I., de Nemours & Co.**
Wilmington 98, Del.
*Explosives and Blasting Supplies*

**Eagle Iron Works**
129 Holcomb Ave., Des Moines 13, Iowa
*Fine Material Screw Washers—Classifiers—Dehydrators; Coarse Material Screw and Log Washers—Dewaterers; Water Scalping and Fine Material Settling Tanks; Drop Balls—Ni-Hard and Semi-Steel; "Swintek" Screen Chain Cutter Dredging Ladders*

**Easton Car & Construction Co.**
Easton, Pa.
*Off-Highway Transportation: Dump Trailers, Truck Bodies, and Cars for Mines, Quarries, and Earth Moving Projects*

**Ensign-Bickford Co.**
Simsbury, Conn.
*Primacord-Bickford Detonating Fuse and Safety Fuse*

**Euclid Division General Motors Corp.**
1361 Chardon Road, Cleveland 17, Ohio
*Heavy-Duty Trucks and Dump Trailers for "Off-Highway" Hauls, Loaders for Earth Excavation, Single and Twin Engine Earth Moving Scrapers*

**Frog, Switch & Mfg. Co.**
Carlisle, Pa.
*Manganese Steel Department—Manufacturers of "Indian Brand" Manganese Steel Castings for Frogs, Switches, and Crossings, Jaw and Gyratory Crushers, Cement Mills, Mining Machinery, Etc., Steam Shovel Parts, Other Miscellaneous Manganese Steel Castings*

**General Electric Co.**
1 River Road, Schenectady 5, N. Y.
*Electric Motors, Controls, Locomotives, Welding Equipment, Coordinated Electric Drives for: Shovels, Drag Lines, Conveyors, Hoists, Cranes, Crushers, Screens, Etc.; Coordinated Power Generating and Distributing Systems Including Generators, Switchgear, Transformers, Cable, Cable Skids, Load Center Substations*

**Gill Rock Drill Co.**
Lebanon, Pa.
*Well Drill Tools and Supplies*

**Goodyear Tire & Rubber Co., Inc.**
Akron 16, Ohio
*Airfoam; Mechanical Goods—Belting (Conveyor, Elevator, Transmission), Hose (Air, Water, Steam, Suction, Miscellaneous), Chute Lining (Rubber); Rims (Truck and Tractor); Storage Batteries (Automobile, Truck, Tractor); Tires (Automobile, Truck, Off-the-Road); Tubes (Automobile, Truck, Off-the-Road, LifeGuard, Safety Tubes, Puncture Seal Tubes)*

**Gruendler Crusher and Pulverizer Co.**
2915 North Market St., St. Louis 6, Mo.
*Rock and Gravel Crushing, Screening and Washing Plants, Jaw Crushers, Roll Crushers, Hammermills, Lime Pulverizers*

## Manufacturers Division—National Crushed Stone Association
(continued)

**Gulf Oil Corp.**
**Gulf Refining Co.**
Gulf Bldg., Pittsburgh 19, Pa.
*Lubricating Oils, Greases, Gasoline and Diesel Fuels*

**Haiss, George, Mfg. Co., Inc.**
**Division of Pettibone Mulliken Corp.**
5720 Empire State Bldg., New York 1, N. Y.
*Bucket Loaders, Buckets, Portable and Stationary Conveyors, Car Unloaders*

**Harnischfeger Corp.**
4400 West National Ave., Milwaukee 14, Wis.
*A Complete Line of Power Excavating Equipment, Overhead Cranes, Hoists, Smootharc Welders, Welding Rod, Motors and Generators, Diesel Engines*

**HarriSteel Products Co.**
420 Lexington Ave., New York 17, N. Y.
*Woven Wire Screen Cloth*

**Hayward Co.**
50 Church St., New York 7, N. Y.
*Orange Peel Buckets, Clam Shell Buckets, Electric Motor Buckets, Automatic Take-up Reels*

**Heidenreich, E. Lee, Jr.**
**Consulting Engineers**
75 Second St., Newburgh, N. Y.
*Plant Layout, Design, Supervision; Open Pit Quarry Surveys; Appraisals—Plant and Property*

**Hendrick Mfg. Co.**
Carbondale, Pa.
*Perforated Metal Screens, Perforated Plates for Vibrating, Shaking, and Revolving Screens; Elevator Buckets; Test Screens; Wedge Slot Screens; Open Steel Floor Grating*

**Hercules Powder Co.**
Wilmington 99, Del.
*Explosives and Blasting Supplies*

**Hetherington & Berner Inc.**
701-745 Kentucky Ave., Indianapolis 7, Ind.
*Asphalt Paving Machinery, Sand and Stone Dryers*

**Hewitt-Robins Incorporated**
666 Glenbrook Road, Stamford, Conn.
*Belt Conveyors (Belting and Machinery); Belt and Bucket Elevators; Car Shake-outs; Feeders; Industrial Hose; Screen Cloth; Sectional Conveyors; Skip Hoists; Stackers; Transmission Belting; Vibrating Conveyors, Feeders, and Screens; Design and Construction of Complete Plants*

**Hoyt Wire Cloth Co.**
Abraso St., P. O. Box 22, Lancaster, Pa.
*Aggregate Wire Screens Made of Super-tough and Abraso Wire—Smoothtop, Longslot, Oblong Space and Double Crimp Construction—For All Makes of Vibrators*

**Hughes Tool Co.**
P. O. Box 2539, Houston 1, Texas
*Drills and Drilling Equipment*

**Illinois Powder Mfg. Co.**
506 Olive St., St. Louis 1, Mo.
*Gold Medal Explosives*

**Ingersoll-Rand Co.**
11 Broadway, New York 4, N. Y.
*Rock Drills, Quarrymaster Drills, Jackbits, Bit Reconditioning Equipment, Portable and Stationary Air Compressors, Air Hoists, Slusher Hoists, Air Tools, Diesel Engines, Pumps*

**Insley Manufacturing Corp.**
801 North Olney St., Indianapolis 6, Ind.
*Concrete Carts and Buckets; 1/2 to 2 Cu. Yd. Cranes and Shovels—5 to 30 Tons Capacity*

**Iowa Manufacturing Co.**
916 16th St., N.E., Cedar Rapids, Iowa
*Rock and Gravel Crushing, Screening, Conveying and Washing Plants. Hot and Cold Mix Asphalt Plants, Stabilizer Plants, Impact Breakers, Screens, Elevators, Conveyors, Portable and Stationary Equipment, Hammermills, Bins*

**Jaeger Machine Co.**
550 West Spring St., Columbus 16, Ohio
*Portable and Stationary Air Compressors, Self-Priming Pumps, Truck Mixers, Concrete Mixers, Road Paving Machinery, Hoists and Towers; Rubber-Tired Front End Loaders*

**Jeffrey Manufacturing Co.**
East First Ave., Columbus 16, Ohio
*Elevator Buckets; Car Pullers; Chains; Conveyors: Belt, Drag, Apron, Vibrating; Idlers; Crushers; Pulverizers; Elevators; Feeders; Pillow Blocks; Stationary Plants; Screens*

**Johnson-March Corp.**
1724 Chestnut St., Philadelphia 3, Pa.
*Dust Allaying Equipment*

## Manufacturers Division—National Crushed Stone Association

(continued)

**Joy Manufacturing Co.**
333 Henry W. Oliver Bldg., Pittsburgh 22, Pa.
*Drills: Blast-Hole, Wagon, Rock, and Core; Air Compressors: Portable, Stationary, and Semi-Portable; Aftercoolers; Portable Blowers; Carpullers; Hoists; Multi-Purpose and Portable Rock Loaders; Air Motors; Trench Diggers; Belt Conveyors; "Spaders"; "String-a-Lite" (Safety-Lighting-Cable); Backfill Tampers; Drill Bits: Rock and Core*

**Kennedy-Van Saun Mfg. & Eng. Corp.**
2 Park Ave., New York 16, N. Y.
*Crushing, Screening, Washing, Conveying, Elevating, Grinding, Complete Cement Plants, Complete Lime Plants, Complete Lightweight Aggregate Plants, Synchronous Motors, Air Activated Containers for Transportation of Pulverized Material, Cement Pumps, and Power Plant Equipment*

**Kensington Steel Co.**
505 Kensington Ave., Chicago 28, Ill.
*Oro Alloy and Manganese Steel Castings: For Shovels—Dipper Teeth, Crawler Treads; For Crushers—Jaw Plates, Concaves, Mantles, Bowl Liners; For Pulverizers—Hammers, Grate Bars, and Liners; For Elevators and Conveyors—Chain, Sprockets; For Tractors—Rail Links and Grouser Plates; Drag Line Chain*

**King Powder Co., Inc.**
Cincinnati, Ohio
*Detonite, Dynamites, and Blasting Supplies*

**Koehring Co.**
3026 West Concordia Ave., Milwaukee 16, Wis.
*Excavating, Hauling, and Concrete Equipment*

**Le Roi Co.**
**Cleveland Rock Drill Division**
12500 Berea Road, Cleveland 11, Ohio
*Air Compressors—Portable 60 Cfm. to 600 Cfm. Gas or Diesel; Tractairs—Combined Tractor with 105 Cfm. Air Compressor; Engines; Generator Sets; Rock and Wagon Drills; Jumbo Drill Rigs, Drifters, Stopers, Self Propelled Drill Rigs; Concrete Mixers; Front End Loaders*

**Linde Air Products Co., Division of Union Carbide and Carbon Corp.**
30 East 42nd St., New York 17, N. Y.
*Oxygen, Acetylene, Welding and Jet Piercing Equipment and Supplies*

**Link-Belt Co.**
300 West Pershing Road, Chicago 9, Ill.
*Complete Stone Preparation Plants; Conveyors, Elevators, Screens, Washing Equipment, Speed-O-Matic Shovel-Cranes—Draglines and Power Transmission Equipment*

**Ludlow-Saylor Wire Cloth Co.**
634 South Newstead Ave., St. Louis 10, Mo.
*Woven Wire Screens and Wire Cloth of Super-Loy, Steel, and All Commercial Alloys and Metals*

**Mack Motor Truck Corp.**
350 Fifth Ave., New York 1, N. Y.
*On- and Off-Highway Trucks, Tractor-Trailers, Six-Wheelers, from 5 to 30 Tons Capacity, both Gasoline- and Diesel-Powered*

**Marion Power Shovel Co.**
617 West Center St., Marion, Ohio
*A Complete Line of Power Shovels, Draglines, and Cranes*

**McLanahan & Stone Corp.**
200 Wall St., Hollidaysburg, Pa.
*Complete Pit, Mine, and Quarry Equipment—Crushers, Washers, Screens, Feeders, Etc.*

**Murphy Diesel Co.**
5317 West Burnham St., Milwaukee 14, Wis.
*Engines and Power Units—90 to 246 Hp.; Generator Sets—60 to 154 Kw.; Marine Engines—90 to 225 Hp.; Dual-Fuel Engines—135 to 180 Hp.; Mechanical and Electric Power Simultaneously*

**National Container Corp. of Ohio**
**Multi-Wall Paper Bag Division**
Jaite, Ohio
*Multi-Wall Paper Bags, Sewn and Pasted Style for Packaging Lime, Cement, Plaster, Etc.*

**New York Rubber Corp.**
100 Park Ave., New York 17, N. Y.
*Conveyor Belting: Stonore, Dependable, and Cameo Grades; Transmission Belting: Silver Duck Duroflex, Soft Duck Rugged, Commercial Grade Tractor*

**Nordberg Mfg. Co.**
3073 South Chase Ave., Milwaukee 7, Wis.
*Symons Cone and Gyratory Crushers; Gyradisc; Grinding Mills; Stone Plant and Cement Mill Machinery; Vibrating Screens and Grizzlies; Diesel Engines and Diesel Driven Generator and Pumping Units; Mine Hoists; Track Maintenance Machinery*

# Manufacturers Division—National Crushed Stone Association
(continued)

**Northern Blower Co.**
6409 Barberton Ave., Cleveland 2, Ohio
*Dust Collecting Systems, Fans—Exhaust and Blower*

**Northwest Engineering Co.**
135 South LaSalle St., Chicago 3, Ill.
*Shovels, Cranes, Draglines, Pullshovels*

**Olin Industries, Inc.**
**Explosives Division**
East Alton, Ill.
*Dynamite, Black Powder, Blasting Caps, Blasting Supplies*

**Osgood-General**
Osgood St. and Cheney Ave., Marion, Ohio
*Power Shovels, Cranes, Draglines, Hoes, Etc., 3/8 to 2 1/2 Cu. Yd.*

**Pennsylvania Crusher Co.**
323 South Matlack St., West Chester, Pa.
*Single Roll Crushers, Impactors, Hammermills, Ring Type Granulators, Kue-Ken Jaw Crushers, Kue-Ken Gyracones, Dixie Non-Clog and Standard Hammermills*

**Pettibone Mulliken Corp.**
4710 West Division St., Chicago 51, Ill.
*Material Handling Buckets, Clamshells, Draglines, Pullshovels, Dippers, Shovel Dippers, Pumps, Hammermills, Front End Loaders, Bucket Conveyor Loaders, Fork and Bucket Loaders, Speed Swing Loaders, Speed Swing Yard Cranes, Motor Graders, Manganese Steel Castings*

**Pioneer Engineering Works, Inc.**
1515 Central Ave., N. E., Minneapolis 13, Minn.
*Jaw Crushers, Roll Crushers (Twin and Triple), Vibrating and Revolving Screens, Feeders (Mechanical, Grizzly, Apron, and Pioneer-Oro), Belt Conveyors, Portable and Stationary Crushing and Screening Plants, Washing Plants, Mining Equipment, Cement and Lime Equipment, Asphalt Plants and Finishers*

**Pit and Quarry Publications, Inc.**
431 South Dearborn St., Chicago 5, Ill.
*Pit and Quarry, Pit and Quarry Handbook, Pit and Quarry Directory, Concrete Manufacturer, Concrete Industries Yearbook*

**Productive Equipment Corp.**
2926 West Lake St., Chicago 12, Ill.
*Vibrating Screens*

**Quaker Rubber Corp.**
**Division of H. K. Porter Co. of Pittsburgh**
Tacony and Milnor Sts., Philadelphia 24, Pa.
*Conveyor Belts, Hose, and Packings*

**Radio Corporation of America**
**Engineering Products Department**
**Industrial Equipment Section**
Front and Cooper Sts., Bldg. 15-1, Camden 2, N. J.
*Electronic Metal Detectors*

**Rock Products**
309 West Jackson Blvd., Chicago 6, Ill.

**Rogers Iron Works Co.**
11th and Pearl Sts., Joplin, Mo.
*Jaw Crushers, Roll Crushers, Hammermills, Vibrating Screens, Revolving Screens and Scrubbers, Apron Feeders, Reciprocating Feeders, Roll Grizzlys, Conveyors, Elevators, Portable and Stationary Crushing and Screening Plants, Mine Hoists, Drill Jumbos and Underground Loaders*

**Screen Equipment Co., Inc.**
1754 Walden Ave., Buffalo 25, N. Y.
*Seco Vibrating Screens*

**Simplicity Engineering Co.**
Durand, Mich.
*Simplicity Gyrating Screens, Horizontal Screens, Simpli-Flo Screens, Tray Type Screens, Heavy Duty Scalpers, D'Watering Wheels, D'Centegrators, Vibrating Feeders, Vibrating Pan Conveyors*

**SKF Industries, Inc.**
Front St. and Erie Ave., P. O. Box 6731, Philadelphia 32, Pa.
*Anti-Friction Bearings—Self-Aligning Ball, Single Row Deep Groove Ball, Angular Contact Ball, Double Row Deep Groove Ball, Spherical Roller, Cylindrical Roller, Ball Thrust, Spherical Roller Thrust; Pillow Block and Flanged Housings—Ball and Roller*

**Smith Engineering Works**
532 East Capitol Drive, Milwaukee 12, Wis.
*Gyratory, Gyrasphere, Jaw and Roll Crushers, Vibrating and Rotary Screens, Gravel Washing and Sand Settling Equipment, Elevators and Conveyors, Feeders, Bin Gates, and Portable Crushing and Screening Plants*

## Manufacturers Division—National Crushed Stone Association
(concluded)

**Stedman Foundry & Machine Co., Inc.**
Aurora, Ind.
*Stedman Impact-Type Selective Reduction Crushers, 2-Stage Swing Hammer Limestone Pulverizers, Multi-Cage Limestone Pulverizers, Vibrating Screens*

**Stephens-Adamson Mfg. Co.**
Aurora, Ill.
*Belt Conveyors, Elevators, Feeders, Car Pullers, Screens, Skip Hoists, Complete Plants*

**Talcott, W. O. & M. W., Inc.**
91 Sabin St., Providence 1, R. I.
*Belt Fasteners, Belt Lacing, Conveyor Belt Fasteners, and Patch Fasteners*

**Taylor-Wharton Iron & Steel Co.**
High Bridge, N. J.
*Manganese and other Special Alloy Steel Castings; Dipper Teeth, Fronts and Lips; Crawler Treads; Jaw and Cheek Plates; Mantles and Concaves; Pulverizer Hammers and Liners; Asphalt Mixer Liners and Tips; Manganese Nickel Steel Welding Rod and Plate*

**Thew Shovel Co.**
East 28th St. and Fulton Rd., Lorain, Ohio
*"Lorain" Power Shovels, Cranes, Draglines, Clamshells, Hoes, Scoop Shovels on Crawlers and Rubber-Tire Mountings. Diesel, Electric, and Gasoline, 3/8 to 2 Yd. Capacities*

**Torrington Co.**
**Bantam Bearings Division**
3702 West Sample St., South Bend 21, Ind.
*Anti-Friction Bearings; Self-Aligning Spherical, Tapered, Cylindrical, and Needle Roller; Roller Thrust; Ball Bearings*

**Travel Drill Co.**
P. O. Box 1124, Raleigh, N. C.
*"Travel Drill"—Mobile Drill for Secondary Drilling in Quarries and Open Pit Work*

**Traylor Engineering & Mfg. Co.**
Allentown, Pa.
*Stone Crushing, Gravel, Lime, and Cement Machinery*

**Trojan Powder Co.**
17 North 7th St., Allentown, Pa.
*Explosives and Blasting Supplies*

**Tyler, W. S., Co.**
3615 Superior Ave., N. E., Cleveland 14, Ohio
*Woven Wire Screens; Ty-Rock, Tyler-Niagara and Ty-Rocket (Mechanically Vibrated) Screens; Hum-mer Electric Screens; Ro-Tap Testing Sieve Shakers; Tyler Standard Screen Scale Sieves, U. S. Sieve Series*

**Unit Crane & Shovel Corp.**
6411 West Burnham St., Milwaukee 14, Wis.
*1/2 and 3/4 Cu. Yd. Crawler and Rubber Mounted Shovels, Clamshells, Draglines*

**Universal Engineering Corp.**
625 C Ave., N. W., Cedar Rapids, Iowa.
*Jaw Crushers, Roll Crushers, Twindual Roll Crushers, Hammermills, Impact Breakers, Complete Line of Crushing, Screening, Washing and Loading Plants, Either Stationary or Portable for Sand and Gravel, Stone, Aggregates or Aglime, Asphalt Plants*

**Vibration Measurement Engineers**
7665 Sheridan Road, Chicago 26, Ill.
*Seismographic and Airblast Measurements, Seismological Engineering, Blasting Complaint Investigations, Expert Testimony in Blasting Litigation; Nation-wide Coverage*

**Werco Steel Co.**
2151 East 83rd St., Chicago 17, Ill.
*Castings—Manganese, Alloy Steel; Screen Plates—Perforated Steel Screen Sections and Decks; Buckets; Chains; Belt Conveyors, Idlers; Dipper—Shovel; Drop Balls; Wire Cloth; Wire Rope and Related Products*

**Weston Dump Body Co.**
326 S.W. 11th St., Des Moines 9, Iowa
*Combination Lime, Sand, and Gravel Body; Special Bodies for Quarry and Pit Work*

**Wheeler, Delbert**
2408 Harrison St., Topeka, Kans.
*Wheeler Testing Vibrators*

**White Motor Co.**
842 East 79th St., Cleveland 1, Ohio
*On- and Off-Highway Trucks and Tractors—Gasoline- and Diesel-Powered; Industrial Engines, Power Units, Axles, Special Machine Assemblies; All Classes of Service*